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OBSERVATIONS OF ADULT AND LARVAL BEHAVIOR IN THE WINTER SPHINGID, *ARCTONOTUS LUCIDUS* (SPHINGIDAE)

Additional key words: phenology, hostplants, circadian habits, mate location, Bear sphinx moth.

Arctonotus lucidus (Boisduval), the Bear Sphinx, is a poorly known, small green sphingid that occurs along the Pacific coast of the United States and Canada. Part of the reason for the Bear Sphinx's anonymity is its very early season flight, ranging from December in southern California to April in Washington state and British Columbia, when little else is flying. After its description by Boisduval (1852), it was 90 years before Comstock and Henne (1942) described the larva and adult phenology. Those descriptions were based upon specimens reared from eggs on *Oenothera dentata* Jepson. Osborne's (2000) report of larvae on *Clarkia breweri* (A. Gray) E. Greene and *C. modesta* (Jepson) represents the first confirmed record of larvae found on hostplants in nature.

Female specimens are rare in collections: there are only 7 of 285 (2.5%) field collected specimens in the Essig Museum (U.C. Berkeley), the Bohart Museum (U.C. Davis), the Los Angeles County Museum, and the San Diego County Museum combined. The rarity of captured females and larvae explains why so little is known about the species' natural history. The purpose of this note is to describe poorly known aspects of adult behavior including circadian habits (flight times), mating, oviposition, and some larval behavior.

On 2 February 1997 J. Krusc and I captured 30 males (no females) using mercury vapor and UV traps near Chinese Camp, Tuolumne Co., California. On 7 February 1997 we were unsuccessful in attracting any *Arctonotus* to the same traps at the same localities. However, that same evening we took two females and one male at residential lights in the same general area.

Captured females were caged outdoors in Berkeley, Alameda Co., California. Feeding was attempted by forcibly unrolling the proboscis into sugar water (a technique that works with many Lepidoptera). I found that the proboscis was vestigial, flaccid and not capable of reaching the substrate on which the moth was perched. Captive females became active at dusk (1745–1800 h PST) and laid eggs singly or in pairs after brief flights around the enclosure. The two females lived 5 days and laid a combined total of 380 eggs. Approximately half the eggs were maintained out of doors (4–21°C), and the rest were brought indoors (16–21°C). Indoors the eggs turned from pale green to yellow in 7 days and hatched 9 days following deposition. The eggs maintained outside hatched in 19 days, 10 days after those maintained indoors. Larvae were fed *Fuschia thymefolia* Kunth, *Clarkia unguiculata* Lindley, *C. amoena* Lehm., and *Oenothera* species (all Onagraceae). Osborne (in press) provides an excellent description of larval biology, to which I only add the observation that large (5 cm) 5th instar larvae regularly hide at the base of the hostplant during non-feeding periods; mature larvae fed mostly in the morning and late afternoon. The larvae range from nearly all green with yellow spiracles to pink and black to all black and this habit occurred regardless of color form.

FIG. 1. Female *Arctonotus lucidus* in 'calling' posture. Photo by Daniel Rubinoff.

Larvae began to burrow in soil in preparation for pupation 36–45 days after egg hatch. Mortality was high at this stage: of 45 larvae that burrowed, only 18 pupated. Larvae pupated under dead leaves and pieces of wood, just under the soil surface, and up to 16.5 cm underground in the rootball of senescing hostplants. Pupation usually occurred in firmly packed ovate cells. The cremaster possesses a bifurcate tip as depicted by Osborne (1995) for *Proserpinus clarkiae* (Boisduval) (Sphingidae).

The 18 pupae were maintained outside in a ventilated plastic tub in Berkeley until November when they were placed in a refrigerator at 1.7°C ± 1°C. No development was evident in the pupae until they had been moved from refrigeration to outside temperatures (between 8–20°C) for more than 45 days. J. Kruse (pers. com.) found that daily cycling of pupae removed from a refrigerator (3°C) to room temperature (18°C) for approximately 4–8 hours, also induced eclosion. The green coloration of the developing wings was visible through the pupal cuticle for two days before the moths emerged. The cuticle became very soft 24 hours before emergence.

Adults eclosed from 8–19 March 1998, usually between 1800 and 1900 h PST; they took 1–2 hours to dry their wings. Adults in cages were active only from 1800 to 1930 h PST, though mating occasionally lasted a few hours longer. Virgin females rested on the substrate, everting and pulsating the papillae anales to disperse pheromone (Fig. 1). When a male was placed in the same enclosure he rapidly approached the female and mated. If no male arrived by 2000 h PST, females stopped calling until the next sunset. One male fertilized three females; those females laid 369, 397, and 401 eggs respectively.

Arctonotus lucidus pupae apparently are able to develop when surface temperatures still regularly fall below freezing. Eggs hatch and larvae begin development when most apparent hostplants are less than 2 cm high, and night temperatures occasionally fall below 0°C.

Hodges (1971) stated that adults can be collected during the day while nectaring on flowers. I suspect this report to be in error since all collections throughout the range of the moth, that I have been able to document, were made at lights, and none of the moths I reared was active during the day. Moreover, the adults do not feed.

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Literature Cited

Boisduval, J. 1852. Annales de la Societé Entomologique de France, 2nd series 10:319.

Comstock, J. A. & C. Henne. 1942. The early stages of *Arctonotus lucidus* Bdv. (Lepidopt.). Bull. South. Calif. Acad. Sci. 41(3):167–171.

Hodges, R. W. 1971. Moths of North America, north of Mexico, Fascicle 21(Sphingidae). 170 pp.

Osborne, K. H. 1995. Biology of *Proserpinus clarkiae* (Sphingidae). J. Lepid. Soc. 49(1):72–79.

Osborne, K. H. 2000. Additional notes on *Proserpinus clarkiae* and *Arctonotus lucidus* (Sphingidae) life histories from the Pacific coast of North America. J. Lepid. Soc. 53(4):170–172.

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EMERGENCE OF PARASITIC FLIES FROM ADULT *ACTINOTE DICEUS* (NYMPHALIDAE: ACRAEINAE) IN ECUADOR

Additional key words: parasitoid, adult Lepidoptera, neotropics, *Arachidomyia.*

A parasitoid is defined as 'an organism which develops on or in another single (host) organism, extracts nourishment from it, and kills it as a direct or indirect result of that development' (Eggleton & Gaston 1990). In contrast parasites rarely kill their hosts and predators always consume more than one host. In addition, parasitoids possess a free-living adult stage (whereas many parasites do not), and do not reproduce inside the host (as do many parasites). Insects with parasitoid life cycles are known from many taxanomic groups including many families of Hymenoptera and Diptera (Eggleton & Belshaw 1992), yet knowledge of host specificity and parasitoid lifecycles remains patchy. Host relationships are known for only a small percentage of parasitoid taxa in the tropics (e.g., references in Hanson & Gauld 1995), and many parasitoid species remain undescribed due to their often small size and highly specialized lifestyles (Gaston 1991). The emergence of parasitoids from adult Lepidoptera is infrequently reported in the literature (e.g., Marshall 1896, Cockayne 1911, Edelsten 1933, DeVries 1979, Smith 1981, McCabe 1998). The following record of sarcophagid flies emerging from adult butterflies in Ecuador represents the first record of this in several years, and only the second record involving Sarcophagidae.

On 8 December 1996 three female *Actinote diceus* Latreille were collected at Cabañas San Isidro, located at around 2000 meters elevation in north-eastern Ecuador. All were flying normally along a road cut through disturbed cloud forest and cattle pasture. At the time of collection all three butterflies were killed by a quick pinch to the thorax, as described by DeVries (1987), placed together inside a glassine envelope, and marked with the date and locality. The specimens were then placed together in a plastic tub with other specimens collected that day and returned to the lab. Upon arrival at the lab and inspection of the specimens, two fly pupal exuviae were found inside the envelope with the three *Actinote* females. Two adult sarcophagid flies were also present inside the envelope. These adults were identified using Shewell (1987) as belonging to the genus *Arachidomyia* Townsend. Due to eclosion inside the glassine envelope, both specimens were badly damaged and could not be identified to species. Another empty puparium was found in an envelope containing a fourth individual female *A. diceus* collected on the same date, but no adult fly was recovered. Lepidopteran specimens were retained in the collection of the senior author and the dipteran specimens were deposited in the Tulane University collection.

Sarcophagid flies develop on a wide variety of food resources and range in habit from detritivores to predators and parasitoids of invertebrate and vertebrate hosts (Clausen 1940). The parasitoid habit appears to have evolved on many separate occasions, and about half